

# **A Plan for Measuring Environmental Outcomes Associated with Conservation Practices: The National Resources Inventory-Conservation Effects Assessment Project (NRI-CEAP)**

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## **Purpose and Scope of the Project**

The 2002 Farm Bill substantially increased funding levels for the Environmental Quality Incentives Program (EQIP) and the Conservation Reserve Program (CRP), authorized continued funding for other conservation programs, and established new conservation programs. Overall, the 2002 Farm Bill authorized Federal expenditures for conservation practices on farms and ranches in the U.S. at a level about 80 percent above the level set under the 1996 Farm Bill. While it is widely recognized that these conservation programs will protect millions of acres from soil erosion, enhance water and air quality, promote wetland and wildlife habitat restoration and preservation, and conserve agricultural water use, the environmental benefits have not been previously quantified and reported at the national level. Tracking the environmental benefits of these programs will allow policy-makers and program managers to implement and modify existing programs and design new programs to more effectively and efficiently meet the goals of Congress.

The National Resources Inventory (NRI) is a statistical survey designed to help gauge natural resource status, conditions and trends on the Nation's nonfederal land. The NRI is currently in transition from a 5-year cycle to an annual cycle of data collection. As part of this transition, the NRI will be structured to capture environmental information on all conservation programs within USDA. The NRI – Conservation Effects Assessment Project (NRI-CEAP) will provide the farming community, the general public, OMB, legislators, and others involved with environmental policy issues an accounting of the environmental benefits obtained from USDA conservation program expenditures. Annual reports summarizing the benefits of conservation programs will be produced beginning in 2005 and extending through 2008.

The scope of the project covers most of the conservation practices implemented through EQIP, CRP, Wetland Reserve Program (WRP), Wildlife Habitat Incentives Program (WHIP), and NRCS Conservation Technical Assistance. Conservation practices (or best management practices, BMPs) that will be emphasized include the NRCS Core 4 practices (conservation buffers, nutrient management, pest management, and tillage management) plus irrigation management practices, drainage management practices, manure management practices, establishment of wildlife habitat, and wetland protection and restoration. Environmental benefits will be estimated for each of the five resource concerns that conservation programs are designed to address:

- Water quality (nutrient, pesticide, and sediment delivery to lakes, rivers, and streams)

- Soil quality (including soil erosion and carbon storage)
- Water conservation (including flood and drought protection)
- Air quality
- Wildlife habitat

Benefits will be estimated separately for agricultural land use categories to which most conservation practices apply:

- Cropland, including cropland enrolled in CRP
- Grazing lands and agro-forestry
- Wetlands

While some information on the effects of conservation practices is available from the research community, sufficient information for conducting a national assessment is presently not available for any resource concern or land use category. Assessment of water quality, soil quality, and water conservation benefits on cropland is possible with the collection of additional data at the national level because of past investments in environmental effects research and non-point source model development. For the remaining categories, however, analytical approaches need to be developed and, in some cases, additional research conducted before national level estimates of benefits can be made.

Consequently, this project is an on-going mix of research, data collection, model development, and model application. The initial focus of the project is on water quality (nutrients and sediment), soil quality, and water conservation on cropland because the modeling technology for estimating these benefits at the national level is presently available. Funding is allocated during the first two years of the project to collect the data needed to estimate the water quality, soil quality, and water conservation benefits for cropland. Cropland will continue to be an emphasis throughout the project because most of the conservation program funding is allocated to conservation practices related to cropland.

Estimates of benefits for wildlife habitat, air quality, and reductions in pesticide losses from farm fields will come later in the project as approaches are developed and appropriate national-level models and databases are constructed. Similarly, conservation benefits for grazing lands, wetlands, and agro-forestry land will be made later in the study as suitable modeling approaches are developed and data collection needs are met. Throughout the project, modeling capabilities and databases will be enhanced for all estimates, and initial estimates will be revised to reflect the improved capabilities and information developed during the course of the project.

This project is a multi-agency effort lead by NRCS and implemented within the National Resources Inventory Program. Collaborators include the Farm Service Agency (FSA), the Agricultural Research Service (ARS), Cooperative State Research, Education, and Extension Service (CSREES), the National Agricultural Statistics Service (NASS), and the Office of Risk Assessment and Cost Benefit Analysis (ORACBA). This core group of agencies will coordinate with other Federal agencies involved in natural resource issues, such as the Forest Service (FS), Economic Research Service (ERS), US Environmental Protection Agency, and US Geological Survey (USGS), and seek opportunities for further collaboration during the course of the project. In addition, NRCS will sponsor forums throughout the course of the project to obtain comments

and suggestions from academic institutions, state agencies, private organizations, and the public on the NRI-CEAP approach and findings.

The principal focus for this project is to produce a national assessment of environmental benefits of conservation programs to support policy decisions and program implementation. It is recognized, however, that a full set of conservation benefits is possible only at finer scales of resolution where more information is available on conservation practices and their effects. Therefore, the project has two major components: 1) the National Assessment, and 2) Watershed Assessment Studies. The national assessment provides estimates of conservation benefits at the national scale for annual reporting. The watershed studies provide more detailed assessments in a few selected watersheds, provide a framework for evaluating and improving the performance of the national assessment models, and allow for additional research on the effects of conservation practices for different resource characteristics (such as climate, terrain, land use, and soils).

Each of these components is presented in more detail in the following sections, concluding with an overview of the organization of NRI-CEAP activities. (Detailed work plans for each of the two components will be prepared at the initiation of the project.)

## **National Assessment Component**

The purpose of the national assessment is to report, on an annual basis, the environmental benefits associated with the implementation of conservation practices during that year. Initially, these will include the following estimates for cropland: reductions in soil and nutrient losses from cropland fields, increased water use efficiency and soil quality enhancement within the field, and water quality improvements in terms of reductions in in-stream nutrient and sediment concentrations. As additional models and databases are developed during the course of the project, conservation benefits associated with other resource concerns and land use categories will also be reported annually.

The National Resources Inventory will provide the basis for the national assessment. The NRI is a scientifically-based, longitudinal panel survey designed to assess conditions and trends of soil, water, and related resources of the Nation's non-federal lands. The NRI is conducted for the U.S. Department of Agriculture by NRCS, in cooperation with the Iowa State University Statistical Laboratory, and provides critical information to address agricultural and environmental issues at national, regional, and state levels. Data gathered in the NRI are linked to NRCS Soil Survey and climate related databases. These linked data, along with NRI's historical data (for 1982 – 2001), form the basis for unique modeling applications and analytical capabilities. The NRI sampling frame captures the diversity of the Nation's agricultural resource base (soils, topography, and climate), which is a critical factor in estimating benefits of conservation practices.

While the NRI is designed to provide statistical information on the natural resources on private lands, it can also be used as an analytical framework for simulation modeling. NRCS has previously made extensive use of the NRI as an analytical framework for modeling to address

issues related to natural resources and conservation. For these applications, the NRI sample points are treated as "representative fields." Data on field management activities are obtained from farmer surveys and integrated with the information on land use and soil characteristics at each NRI sample point. This information is then used in conjunction with field-level fate and transport process models to estimate the loss of materials from farm fields or other outcomes such as accumulation of soil carbon. The statistical sampling weight (expansion factor) associated with each sample point is used to aggregate the modeling results to the national or regional levels. The resulting simulation model captures the diversity of land use, soils, climate, and topography from the NRI, estimates the loss of materials from farm fields at the field scale where the science is best developed, and provides a statistical basis for aggregating results to the national and regional levels. (For examples of NRI modeling applications, see reports available at [www.nrcs.usda.gov/technical/land/pubs/](http://www.nrcs.usda.gov/technical/land/pubs/).)

### **Analytical Approach to Estimating Water Quality, Soil Quality, and Water Conservation Benefits for Cropland**

A simulation model will be constructed using the NRI as the analytical framework to estimate water quality, soil quality, and water conservation benefits associated with cropland. The approach will be similar to previous NRCS modeling applications using the NRI. Benefits will be estimated using field-level physical process models (EPIC and APEX), NRI information at sample points, and additional data on conservation practices and farming practices associated with a subset of NRI sampling points.

Farm Surveys. The physical process models require detailed information on farming practices, such as crop rotation, tillage, chemical use, and the conservation practices employed. NRCS will collaborate with NASS and FSA in the acquisition of this additional information by conducting a farmer survey at a sub-sample of NRI sample points. The survey will utilize personal interviews to administer a questionnaire that is designed to obtain from farm operators field-specific data associated with the selected sample units. Specific questions are asked about physical characteristics of the field and technical aspects of conservation practices associated with the field. Other questions deal with production activities before and after implementation of specific conservation practices, and with the operator's participation in conservation programs. FSA will assist by providing information on land ownership and identification of the operator. The survey will be conducted in the fall of each year beginning in 2003 and extending through 2007. Approximately 10,000 interviews will be conducted each year.

Estimation of National-Level Benefits. Field-level modeling results will be combined with performance reporting data (EQIP practices and Performance and Results Measurement System databases) to provide estimates of the benefits of conservation practice implementation at the national level. For example, performance-reporting data will provide the number of acres of buffers installed. These data are available by county and can be aggregated to suitable geographic areas to match the aggregations of the national assessment modeling data. The field-level models will provide per-acre estimates of the soil and nutrient savings for specific regions of the country. Multiplying the benefits per acre times the number of acres results in a national estimate of the benefits of buffers in terms of material savings at the edge of the field. Similar approaches will be used to calculate benefits for other conservation practices. Benefit measures

will be in terms of the reductions in sediment and loss of soil and nutrients from farm fields and reductions in water use on irrigated cropland.

In addition to the field-level modeling, water quality benefits will also be assessed at the 8-digit watershed scale using SWAT/HUMUS. HUMUS is a system of databases on land use and sources of non-point and point source pollutants that are used with the SWAT model, a hydrology model that simulates the transport of water from the land to receiving streams and routes the flow downstream to the next watershed or to the oceans and estuaries, to produce estimates of in-stream concentrations of nutrients and sediment associated with agricultural land in the watershed. Outputs from the EPIC and APEX field-scale model runs will be combined with HUMUS databases and the SWAT watershed model to estimate in-stream concentrations of nutrients and sediment at the outlet of each watershed in agricultural regions. This will allow estimation of the reduction in in-stream concentrations attributable to implementation of conservation practices. Other outcome measures are also possible, such as: (1) reductions in the number of days during the year that in-stream nitrogen concentrations exceed the drinking water standard; and (2) reductions in the number of days during the warm summer months that in-stream nitrogen and phosphorus concentrations exceed critical thresholds related to algal blooms and eutrophication.

### **Model Development for Other Resource Concerns and Land Use Categories**

To date, NRI-modeling approaches have not been developed for air quality and wildlife enhancement on cropland, nor have applications been developed for the other three land use categories—grazing lands, wetlands, and agro-forestry land. The goal is to develop these applications over the course of this project. During the first year of the project, teams of subject area experts will be formed to identify the appropriate indicators and performance measures and to develop the NRI-modeling approaches needed to estimate the environmental benefits. In expanding the NRI observations, other data may need to be obtained from farmer surveys. It is anticipated that some of these indicators and performance measures will be reported in the 2006 annual report, and that the 2007 and 2008 annual reports will include a full set of outcome performance measures.

Throughout this process, NRCS will work closely with other agencies and with non-governmental entities. Workshops will be held to integrate ideas from subject area experts around the country, and opportunities for collaboration will be sought. These estimates will improve over time as models are strengthened and additional data are obtained through the NRI program.

### **Model Evaluation**

To assure that the national assessment is based on the best possible models and fully captures the existing research findings on the environmental effects of conservation practices, a component of the national assessment will focus on model evaluation.

As a first step in the evaluation, ARS and CSREES will organize a review of research literature and prepare a summary of what is known about the environmental (and economic) effects of conservation practices, including a synopsis of what is not known and identification of research needs. This study will establish the boundaries of what science knows about this subject, and

consequently also establish the scientific underpinning for the national assessment. Initially, the ARS National Agricultural Library will prepare a set of abstracts from the published literature for each of the 5 resource concerns from 1985 to the present. Workshops will then be held and, based on presentations and discussions at these workshops, white papers will be prepared and published for each topic area. This literature review and synopsis will be updated periodically throughout the course of the project.

The analytical approach used to make national level estimates of conservation benefits for each resource concern and each land use category will be evaluated to: 1) assure that state-of-the-art modeling capabilities are being used for estimating conservation effects at the national level; 2) incorporate new information on conservation practice effects where needed; 3) evaluate the adequacy of the data available and how those data are used; and 4) recommend improvements and alternative approaches where appropriate.

Model evaluation will be conducted by teams of ARS, NRCS, and other experts. Models used to estimate water quality, soil quality, and water conservation on cropland will be evaluated first. A team of experts will evaluate the way APEX, EPIC, and SWAT/HUMUS models simulate critical processes and will make recommendations on upgrades that are needed. Model evaluations for other resource concerns and land use categories will follow model development and application.

As a part of this evaluation effort, the NRCS Water and Climate Center will evaluate how weather is simulated at NRI sample points and determine what modifications are needed. They will also administer a contract with Oregon State University to produce weather generator parameters that can be used to simulate weather at individual NRI sample points. The ability to simulate alternative weather scenarios at NRI sample points is important for all resource concerns and land use categories.

## **Watershed Assessment Studies Component**

To complement the national assessment, a selection of watershed studies will be conducted. ARS and NRCS will lead the effort for watershed studies, and will collaborate with CSREES, FSA, ORACBA, EPA, and other agencies. There are 5 main objectives to the watershed studies component:

1. To develop a quantitative water quality, soil quality, and water conservation database that documents the benefits of conservation practices, and to collect air quality and wildlife habitat data for future national assessments at selected watersheds. The database will be used to validate and enhance the models used in the national assessment.
2. To conduct an assessment of water quality, soil quality, and water conservation benefits of conservation practices at the watershed scale. This assessment will provide information to verify the accuracy of the national assessment.
3. To determine estimates of uncertainties or ranges in values of benefits from conservation practices at the watershed scale.

4. To develop a set of regionalized models for future national assessments that determines water quality, soil quality, water conservation, air quality, and wildlife habitat benefits from conservation practices.
5. To develop indicators or performance measures for documenting soil quality, air quality, and aquatic and terrestrial habitat benefits from implementing conservation practices at selected watersheds.

It is not intended that estimates of benefits for the watershed studies be aggregated to represent national-level estimates, since many more watersheds would be needed to properly represent the various environmental and resource base characteristics in the country. Rather, the results of the watershed studies will be used to improve the performance of the national assessment models and to demonstrate that a richer set of benefits can be identified and measured when assessed at a finer scale than is possible at the national level.

The selection of the watersheds is important. The objective is to select watersheds where there is already on-going work and provide funding and assistance needed to adapt the watershed models in use for the specific purpose of evaluating water quality benefits associated with implementation of conservation practices.

There are 3 categories of watersheds to be selected. The first is a set of ARS research watersheds where ARS has conservation effects research projects underway. Some of these are long-term research sites, and have associated water quality monitoring data covering several years.

The second set of watersheds are strategic, or targeted, watersheds where ongoing research is particularly appropriate for demonstrating the environmental benefits of conservation programs. Funding will be provided to adapt the on-going efforts to meet the specific objectives of NRI-CEAP. A technical committee comprised of scientists from ARS and NRCS Science and Technology Deputy Area will identify candidate watersheds and determine the extent of support needed for each. Some of the watersheds will be in regions with livestock waste issues (60% of EQIP funds must go to address livestock issues.) Others will be in irrigated cropland regions and will address water conservation issues (\$300 million of EQIP funds are ear-marked for regions of the country with irrigated agriculture and water use issues.) Remaining watersheds will address soil erosion and nutrient management issues in non-irrigated crop production areas.

The third set of watersheds will be selected through the CSREES Competitive Grants Initiative within the CSREES Watersheds Program. Criteria for acceptance of proposals will be established by the steering committee. This will bring in contributions from non-governmental groups that have demonstrated expertise in assessment of conservation benefits at the watershed scale.

## **Organization of NRI-CEAP Activities**

An oversight committee will be established consisting of experts from outside of government to provide guidance and recommendations on the analytical approach and on policy related aspects of the assessment. Within government, a steering committee and an executive steering committee will be established to provide the necessary interagency collaboration and oversight for the project (see Activity Organization Chart for NRI-CEAP) and to assure that coordination and integration of findings occur between the national assessment component and the watershed studies component.



# Activity Organization Chart For NRI-CEAP



